Listing and Amendments to the Claims

This listing of claims will replace the claims that were published in the PCT Application and annexed to the International Preliminary Report on Patentability:

1. (currently amended) An automatic resetting method using electronic means intended for a geometric model of a scene over a picture of the scene, the model and the picture of the scene being stored in the memory of an electronic device in the form of pixel matrices, the scene including fixed references with respect to the remainder of the scene, whereas the references may be specifically detected within the matrices, the picture being taken by a camera arranged in a given zone with respect to the ground in a location of the zone and according to a shot angle determined relative to the scene, the electronic means comparing the picture with the model having been adjusted in perspective by homography for superimposition of the references,
~~characterised in that~~ wherein the electronic device calculates a fine homography function H_f for resetting into three main phases:
- a first preliminary phase of determination of an average resetting homography consisting in determining an average homography function H_m applicable to the model with average adjustment over a sample of pictures of the scene taken previously,
- a second, rough resetting phase consisting after application of the average homography function H_m to the model in determining a rough homography function H_g,
- a third, fine resetting phase consisting after application of the rough homography function H_g to the model in determining a fine homography function H_f.

2. (currently amended) A method according to claim 1, ~~characterised in that~~ wherein in the preliminary step of determination of an average resetting homography, at least one sample picture is selected among a collection of pictures taken of the given location, the references on the sample picture(s) are detected and an average homographic function H_m is calculated

enabling superimposition between the model subjected to the average homographic function and the sample picture(s), superimposition being reached for least error square minimization of the distance between reference points of sample picture(s) and the model subjected to the average homographic function.

3. (currently amended) A method according to claim 1 ~~or 2~~, ~~characterised in that~~ wherein in the second, rough resetting phase:

- in a first step, an extraction process is applied to the picture enabling, according to detection criteria, to detect in the picture matrix of the pixels which may represent references of the scene and to form a first picture reference binary matrix M_{rh} including horizontal contour points and a second picture reference binary matrix M_{rv} including vertical contour points,
- in a second step, for each horizontal reference binary matrix M_{rh}, respectively a vertical reference binary matrix M_{rv}, is calculated a horizontal reference distance matrix M_{dh}, respectively a vertical reference distance matrix M_{dv}, including for each element of the matrix the distance value with respect to the closest reference according to the vertical line, respectively the horizontal line,

for the horizontal reference distance matrix M_{dh} each element of said matrix specifying the distance in number of pixels relative to the reference line along a vertical axis, the distance values on the reference line and those of a column without any reference line pixel being nil, the distance values along the vertical line increasing in absolute value as the element moves away relative to the reference line, the distance values of the elements being of opposite signs on both sides of the reference line,

for the vertical reference distance matrix M_{dv} each element of said matrix specifying the distance in number of pixels relative to the reference line along a horizontal axis, the distance values on the reference line and those of a line without reference line pixel being nil, the distance values along the horizontal line increasing in absolute value as the element moves away relative to the reference line, of the elements being of opposite signs on both sides of the reference line,

- in a third step, all the reference lines of the model are applied the average homographic function H_m in order to produce a binary average adjusted matrix M_{am} which is compared with the vertical M_{dv}, respectively horizontal M_{dh} reference distance matrices, for pixel matching purposes,
with, for each pixel p(i,j) of the average adjusted matrix derived from a resetted pixel of the model belonging to a vertical reference line and positioned at the line i and at the column j of the average adjusted matrix M_{am}, the allocation of a corresponding pixel obtained by adding the value v in i and j of the vertical reference matrix M_{rv} to the value j, and matching the pixels ~~((i,j), (i,j+v))~~,
with, for each pixel p(i,j) of the average adjusted matrix derived from a resetted pixel of the model belonging to a horizontal reference line and positioned at the line i and at the column j of the average adjusted matrix M_{am}, the allocation of a corresponding pixel obtained by adding the value v in i and j of the horizontal reference matrix M_{rh} to the value i, and matching the pixels ~~((i,j), (i+v,j))~~,
a homography function H_{opt} is then calculated by regression with minimisation of the medial of the square of the distance between pairs of matched pixels, the calculation being carried out over n collections of four pairs of matched pixels,
- in a fourth step, the pairs of pixels corresponding to non-aberrant matches are identified,

- in a fifth step, H_{opt} is adjusted by least square regression calculation over all the non-aberrant pixel pairs in order to produce the rough homography H_g.

4. (currently amended) A method according to the claim 3, ~~characterised in that~~ wherein, on the one hand, in the binary average adjusted matrix M_{am}, the pixels take on the value 1 if they correspond to a reference pixel of the resetted model and 0 if not, and, on the other hand, in the fourth step of the second, rough resetting step, a pair of pixels corresponds to a non-aberrant match, if, for the pixel of the average adjusted matrix M_{am} of the match in question, the distance between the pixel matched by using the reference matrices M_{rh}, M_{rv}, and that

obtained by the homography H_{opt} is smaller than or equal to a preset threshold.

5. (currently amended) A method according to claim 3 ~~or 4~~, ~~characterised in that~~ wherein the reference detection criteria are chosen individually or in combination among:
- a specific colour of the reference with respect to the remainder of the scene,
- a specific tone of the reference with respect to the remainder of the scene,
- a specific grey level of the reference with respect to the remainder of the scene,
- a specific shape of the reference, notably a line, an angle between two lines crossing each other, a parallelism between two lines,
- a specific orientation of the reference,
- a line closest and parallel to an edge of the picture matrix.

6. (currently amended) A method according to ~~the~~ claim 3~~,~~ ~~4 or 5~~, ~~characterised~~ wherein ~~in that~~ the extraction process comprises a preliminary Cany-Deriche filtering step of the picture in order to obtain a gradient picture and that the process continues with the gradient picture.

7. (currently amended) A method according to claim 1~~any of the previous claims~~, ~~characterised in that~~ wherein in the third, fine resetting phase, the rough homography H_g is applied to the model and the result is compared to both horizontal and vertical distance matrices with adjustment of the homography by a so-called Powel alternate single-dimension iterative minimisation method.

8. (currently amended) A method according to claim 1~~any of the previous claims~~, ~~characterised in that~~ wherein the pictures evolve with time according to sequences corresponding to different shot locations and/or angles and in that the electronic device comprises means enabling moreover to determine during the first, average resetting preliminary phase, as many average homography functions H_m as there are different shot locations and angles.

9. (currently amended) A method according to claim 1~~any of the previous claims~~, ~~characterised in that~~ wherein the phases and

steps are implemented in the electronic means which are programmable logic units with a programme and that the programmable logic comprises a microprocessor or a digital signal processor ~~(DSP)~~ and, preferably, of the general-purpose or dedicated microcomputer type.

10. (currently amended) A method according to claim 1~~any of the previous claims~~, ~~characterised in that~~ wherein the scene is a sports ground including references in the form of delineating lines, notably a European or American "football" pitch or a tennis ground.

11. (currently amended) Automatic resetting device using electronic means intended for a geometric model of a scene over a picture of the scene, the model and the picture of the scene being stored in the memory of an electronic device in the form of pixel matrices, the scene including fixed references with respect to the remainder of the scene, whereas the references may be specifically detected within the matrices, the picture being taken by a camera arranged in a given zone with respect to the ground in a location of the zone and according to a shot angle determined relative to the scene, the electronic means comparing the picture with the model having been adjusted in perspective by homography for superimposition of the references,
~~characterised in that~~ wherein it comprises means enabling to calculate a fine homography function H_f for resetting into three main phases:

- a first preliminary phase of determination of an average resetting homography consisting in determining an average homography function H_m applicable to the model with average adjustment over a sample of pictures of the scene taken previously,
- a second, rough resetting phase consisting after application of the average homography function H_m to the model in determining a rough homography function H_g,
- a third, fine resetting phase consisting after application of the rough homography function H_g to the model in determining a fine homography function H_f.

12. (currently amended) A device according to claim 11, ~~characterised in that~~ wherein the electronic means are of the general-purpose or dedicated microcomputer type.

13. (original) An information storage medium including a programme intended for operating the device of claim 11.

14. (currently amended) An information storage medium including a programme intended for operating the device of claim 11 and ~~at least~~ according to the method of claim 1 ~~among the method-related claims 1 to 10~~.